

It appears to us, therefore, that for our conditions the advantages of plant-mix construction outweigh the small extra cost. In other sections of the country where climatic conditions are more favorable, or aggregates are more costly, the situation may be entirely different.

ROAD-MIX VS. PLANT-MIX IN BITUMINOUS ROAD CONSTRUCTION

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Mr. Schaub's paper indicates the intelligent approach that Michigan has made to its problem of low-cost bituminous construction. I find very little to criticize and nothing to contradict in his considerations. So, for the purposes of this discussion, I propose to apply similar considerations to the Indiana scene.

Indiana's problem is similar in many respects. Our climate is not greatly different; our aggregates are probably better distributed, both in location and quality; traffic conditions and maintenance problems are quite similar. However, most of our secondary state highway system has been developed through the various stages of traffic-bound, dust palliative, oil mat, and successive surface treatments, and many have developed to higher types. Most of this development was accomplished by "road-mix" methods, during the "twenties," when little other equipment was available. In fact, many of the so-called "road-mix" methods were originated during this period by Indiana highway engineers. However, there is probably a place even now for "plant-mix" methods on our secondary system.

We also have a related problem that is being met with similar considerations. Many of the old grades and alignments have to be improved to meet modern traffic demands. This means abandonment of the old base and quick development of new base and surface. A similar problem is involved on much of the mileage constructed for the counties in the F.A.S. programs.

Indiana has made various attempts to solve this base and surface problem. It is my opinion that there is still much to be desired in our development of quick, adequate, and cheap bases. But I do believe that Indiana's bituminous stabilized surface is the best answer to date to the surface problem. In many respects it is similar to Michigan's "oiled aggregate," though both road-mix and plant-mix methods are permitted in Indiana.

In his discussion of road-mix methods, Mr. Schaub has been more than charitable, considerably more charitable than those in Michigan responsible for the elimination of road-mix methods from their competition. However, if quality of the resulting product is to be given serious consideration, I believe the elimination can be justified.

We may accent the need for good distributor equipment, adjustable spray bars, shapes, location, and size of spray nozzles, uniform pressures, careful driving, "suck-back," etc., yet the ultimate we can hope to accomplish is a uniform distribution of bituminous material per unit of area. Every area must have some depth, and to obtain a spread of aggregate over an old base, even as uniform as a poor distributor can "shoot," approaches physical impossibility. The mixing operation, with road-mix methods, has similar limitations. Under some conditions, even portions of the base materials are worked loose and mixed with the surface materials. The resulting streaks or "lean and fat" spots are a natural result, and it is a real tribute to skilled workmanship to produce results that can be considered even comparable with plant-mix.

It is a natural development for engineers to require more accurate proportioning and for equipment manufacturers to develop the tools and machinery to produce it. Such has been the history of other surface types. However, the original premise was "low cost," and equipment ownership, use, and maintenance are cost factors that cannot be long ignored. They limit competition and increase cost.

It is a long jump from road-mix to "batch type" asphalt plants and driers. The intermediate step is the gravel plant or the continuous type of central mixing plant. Both are capable of close control of proportions and mixing action, and are considerably less expensive to own, operate, and transport.

INDIANA EXPERIENCE

My own experience, as a contractor during the past two seasons, is my background for these opinions. During 1938, we built one project of bituminous stabilized surface for Indiana. The project included considerable work, in addition to the surface. We were ready and were given authority to proceed with surface construction on August 1. We used road-mix methods and worked the remainder of the season to complete six miles to the satisfaction of the state engineers. Snow was flying when we completed our last operation, and the results justified the reluctance of the engineers to accept the work.

During 1939, in addition to a normal amount of other types of work, we built nearly twenty-five miles of bituminous stabilized surface, on seven different projects, and with one

asphalt plant. Our operations were capable of organization, and we developed a degree of efficiency. The completed work was pleasing to the eye, and there was little question of acceptance when the work was completed. Our unit costs were no less than road-mix costs; but the added volume of work handled, in our opinion, justified the small increment in unit costs. Our contract prices for the finished mix in the completed road, including asphalt, varied from \$2.75 per ton to \$3.00 per ton.

We think we can improve both our equipment and our own efficiency in the future. We are really pioneering in this type of construction in Indiana and have acquired all our work by submitting a lower bid than our road-mix competitors. The cost to the State has actually been lower than road-mix on the work we performed.

One vexing problem that we have not solved involves the State Highway Commission personnel. Mr. Schaub did not mention this; so I judge that this problem does not exist in Michigan. Engineers and inspectors during the past season have moved to the site of our work with their families and with the apparent intention of staying for the season or the year. Most of them welcomed our plant-mix methods and co-operated with us in the prompt prosecution of the work. The natural results was that the work was complete on or before the contract completion date, and the state personnel was available for other work. Now, it seems that moving is a personal expense not shared by the employer; so that even though the state has profited, the individual engineer-inspector is penalized for being there. To date, I have heard of no attempt at solution of this problem. I think that I have one to suggest, but I haven't been bothered much lately with requests for my suggestions.

In conclusion, let me say that I have no desire to see road-mix eliminated from the competition in Indiana. Possibly we should retain such methods to insure low costs. However, it is hardly fair to lower standards to accommodate one method and require higher standards of a competing method. Keep the quantities and the construction standards the same, and the contractor will have little complaint.

WPA CO-OPERATION WITH CITY AND COUNTY OFFICIALS ON STREET AND ROAD IMPROVEMENT

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In the operation of a program as extensive as that of the Work Projects Administration, dealing as it does with many governmental units having diversified interests, it is rather